

CHAPTER 4

PLAN FORMULATION & EVALUATION PROCESS



Cobble Weir, Cache Creek Settling Basin – 1958.

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PLAN FORMULATION AND EVALUATION PROCESS

This chapter describes the process for formulating flood damage reduction plans for the Lower Cache Creek area, including the identification of planning objectives, constraints, and planning criteria, and screening measures that would be most effective in reducing flood damage. This chapter also discusses the merits of combining various measures and establishes the preliminary plans to be considered as candidates for selection.

The Corps planning process consists of six basic and iterative tasks:

1. Identifying problems and opportunities, which were discussed in Chapter 3, including defining specific objectives and constraints for plans to reduce flood damages within the study area.
2. Developing an inventory and forecast of critical resources (physical, demographic, economic, and social) relevant to the problems and opportunities under consideration in the planning area, as discussed in Chapter 2.
3. Identifying and assessing potential management measures to achieve objectives and recognizing constraints and combining these measures into preliminary plans. This step includes defining the criteria for formulating and evaluating plans.
4. Evaluating potential effects and screening preliminary plans to select those which best meet the planning objectives and criteria and eliminate others from further detailed consideration.
5. Evaluating and comparing the plans.
6. Providing the rationale for selection of the tentatively recommended plan.

PLANNING OBJECTIVES

The City of Woodland, the Board, and the Corps have identified the following objectives for formulating flood damage reduction plans based on professional judgment and input from concerned residents and public agencies. The primary plan objectives are limited to flood damage reduction. The local sponsor's primary interest at this time is flood damage reduction. Plans will be formulated according to the Federal objective of water and related land resources planning, which requires water resources projects to

contribute to the national economic benefit while protecting the Nation's environmental resources, consistent with Federal, State, and local laws, regulations, and policies.

The specific planning objectives are:

- Maximize the use of existing flood damage reduction facilities prior to constructing new facilities.
- Reduce flood damages in the city of Woodland.
- Protect existing environmental resources and mitigate potential adverse effects to the maximum practical extent.

PLANNING CONSTRAINTS

Constraints to the plan formulation and evaluation process have been identified as follows:

- Minimize the associated costs of the flood damage reduction system.
- Minimize adverse effects to the area's residents as well as environmental, cultural, and agricultural resources.

PLANNING EVALUATION CRITERIA

Four planning process evaluation criteria have been established in Federal principles and guidelines for planning water resource projects to lend more specificity to the planning objectives and provide a uniform set of guidelines for further information and evaluation of plans. They include (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability. These criteria and the manner in which they apply to this study are described below.

COMPLETENESS

Completeness is the extent to which a given plan provides and accounts for all necessary investments or other actions to ensure the realization of the planning objectives. To satisfy the criteria, each plan should:

- Be capable of consistently and reliably providing identified project outputs.
- Need no further actions to ensure complete fulfillment of the stated degree of flood damage reduction.

- Mitigate unavoidable adverse environmental effects as fully as is found to be reasonable and justified.
- Fully compensate or offset adverse hydraulic effects to other areas to the extent justified or required by law.

EFFECTIVENESS

Effectiveness is the extent to which a plan alleviates the identified problems and achieves the planning objectives. Several important factors in measuring the effectiveness are:

- The level and reliability of flood damage reduction provided.
- One or more of the planning objectives addressed.
- Capability of being physically implemented.

EFFICIENCY

Efficiency is the extent to which a plan is the most cost-effective means of alleviating identified flood problems while realizing the specified objectives, consistent with protecting the Nation's environment. It is measured by comparing estimated monetary costs and benefits of the plans.

ACCEPTABILITY

Acceptability is the workability and viability of the plans with other Federal agencies, affected State and local agencies, and public entities given existing laws, regulations, and public policies. Acceptability is measured by:

- Willingness and capability of a non-Federal sponsor to pay its share of the project cost.
- Willingness of local affected governments to work toward agreements allowing implementation of the plans.
- Ability of a plan to minimize or avoid irreversible effects on the environment and irretrievable commitments of nonrenewable resources.
- Ability to obtain required permits and certification.

PERIOD OF ANALYSIS

The economic period of analysis for this study is considered to be 50 years, from 2006 to 2056.

HYDROLOGIC AND HYDRAULIC ANALYSES

Recent hydrologic information for the Cache Creek basin was updated with current information for this feasibility study; refer to Appendix C for more detail. Hydraulic information for this feasibility study was developed from current information and was not based on any previous hydraulic models; refer to Appendix D for more detail. This current hydrologic and hydraulic information was used in the models and analyses for plan formulation, evaluation, and selection.

INITIAL SCREENING OF FLOOD DAMAGE REDUCTION MEASURES

Preliminary nonstructural and structural measures were identified during the initial screening process with the objective of providing increased flood damage reduction to the city of Woodland. Nonstructural measures reduce the threat to public health and safety and flood damages at the point of damage instead of attempting to control the floodwater. Nonstructural measures considered include (1) raising or flood proofing structures, (2) relocating structures, and (3) implementing flood warning and evacuation systems.

Most structural measures to control flood damage are directed at the source of flooding. Structural measures considered during the initial screening process include (1) constructing additional storage, (2) implementing channelization, and (3) installing levees, setback levees, and backup levees. Nonstructural and structural measures reviewed and evaluated during the screening process are shown in Table 4-1.

Table 4-1. Initial Screening of Nonstructural and Structural Measures

Measure	Comparative Cost Range	Environmental Effects	Socioeconomic Effects	Potential for Combining with Other Measures	Status
Nonstructural					
Raising/Flood Proof Structures	High	Minimal	High	Low	Retained
Relocate Structures	High	Extensive	High	Low	Retained
Flood Warning Systems	Low	Minimal	Low	High	Retained
Structural					
Storage	High	Extensive	High	Low	Dropped
Channel Improvements	High	Extensive	High	Medium	Retained
Levee Modification	High	Extensive	Moderate	Low	Retained
Setback Levees	Moderate	Moderate	Moderate	Medium	Retained
Backup Levees	Low	Low	Low	High	Retained

NONSTRUCTURAL

Nonstructural measures reduce flood damages without significantly altering the extent of flooding; that is, nonstructural measures are aimed at reducing flood damage at the point of damage. Nonstructural measures range from physically moving structures to implementing evacuation plans. As a result, the costs associated with assorted nonstructural measures vary considerably.

Raising/Flood Proofing Structures

Approximately 4,000 homes of the approximately 10,000 homes in the Woodland area lie in the 1 in 100 chance (100-year) flood plain. Assuming approximately \$60,000 as a cost to raise an average-size home, the cost to raise 4,000 homes would be \$240 million. This cost does not include the cost to raise or flood proof industrial and commercial structures or the costs associated with raising residential garages and other residential structures. In addition to these costs, there may be stability issues associated with raising older homes, as well as elevated costs associated with raising homes initially erected on concrete slabs instead of block foundations.

Socioeconomic effects are judged to be high since families are displaced during raising of homes. Other significant damages would continue, such as the prolonged flooding of the portion of I-5 east of the city, the flooding of the sanitary sewer system, and the flooding of hazardous materials stored within the flood plain.

Raising or flood proofing existing structures in urban areas would have extraordinarily high costs. Raising or flood proofing of existing structures in sparsely populated areas was considered further as a measure to mitigate project-induced effects.

Relocate Structures

As indicated above, approximately 4,000 homes in the Woodland area lie within the 1 in 100 chance (100-year) flood plain. Costs associated with moving homes (\$100,000 for an average-size house) and businesses to new locations would be prohibitive. In addition, structural damage experienced during movement of the homes may be extremely costly. Families would have to be temporarily housed, and environmental effects could be significant, given the new home site requirement. The other socioeconomic and continuing flood damages would be similar to those associated with raising and flood proofing.

Excluding land acquisition costs, the cost to move homes is even greater than the cost to raise homes. Relocating structures in urban areas was not considered further. Relocating structures in sparsely populated areas was considered further as a measure to mitigate project-induced effects.

Flood Warning System

A flood warning system is an operational framework designed to integrate a set of independent components which collect watershed data; analyze, interpret, and forecast downstream river stages; recognize potential threats of inundation within the flood plain; convey flood threat information to affected local agencies; coordinate public and private responses to imminent flood events; and facilitate implementation of preparedness and recovery plans. This type of system can provide warning time to close flood gates, to prepare for flood fighting, and to evacuate citizens from flood areas. Flood warning systems that have been recently developed have cost about \$1 million (Corps, Reno flood warning system study).

The existing flood warning system includes a river forecast for Cache Creek at the Rumsey stream gage near the town of Rumsey produced by the National Weather Service (NWS) and the California-Nevada River Forecast Center (CNRFC). This forecast allows about 15 hours of notice to the Rumsey area for storms centered upstream from Rumsey. No river forecast is conducted downstream from Rumsey, but it is known that the travel time from Rumsey to the Woodland area is about 10 hours, for a total warning time of 25 hours for Woodland for storms centered upstream from Rumsey. Storms centered downstream from Rumsey can have a lag time of as little as 11 hours to reach the Yolo stream gage near the town of Yolo and the city of Woodland. Expanding the river forecast to include the Yolo gage would provide additional reliability to the flood warnings for the residents of Yolo County and Woodland.

The City of Woodland and Yolo County are responsible for receiving and responding to the flood threats identified by the CNRFC. Receiving information from the CNRFC can take several hours. Acquiring a storm watch system that allows access to real-time precipitation and streamflow data would allow the city and county to recognize a threat sooner and give several more hours to protect property and evacuate citizens. A reverse “911” system would save more time in notifying the public. This measure was considered further as a flood damage reduction measure.

STRUCTURAL

Structural measures identified by the Corps and local interests to increase flood damage reduction include upstream storage, levee modifications/new levee construction, channel improvements, and combinations of these measures.

Storage

In 1988, the Corps evaluated the economic feasibility of several combinations of storage space and downstream objective peak flows. The objective was to attenuate the peak flow downstream on Cache Creek so that the chance of flooding would be no more frequent than 1 in 100 in any given year. The only plan that was economically feasible

was a dam and reservoir at the Blue Ridge site on Cache Creek just upstream from Rumsey. The project design was a roller-compacted concrete dam with a 300-foot-wide overflow type spillway. The proposed reservoir had a surface area of 7,000 acres and a storage capacity of 945,000 acre-feet. This dam was further studied in 1994 by the Corps in the West Side Tributaries reconnaissance study. This study concluded that the damsite is not feasible because, among other reasons, it straddles five seismic faults. Furthermore, there appears to be no local support for a multipurpose dam and reservoir. Therefore, this measure was not carried forward.

In the reconnaissance study, flood storage on Cache Creek was evaluated at three other sites: Bear Creek, Wilson Valley, and a third site just downstream from the existing Capay Diversion Dam. The results are summarized below.

The Bear Creek site was first identified by the State Department of Water Resources in the early 1970's as part of the State's Eel River project. The Corps' reconnaissance hydrologic analyses indicated that even when 100 percent of the runoff is stored at the Bear Creek site, downstream flows in Cache Creek would only be reduced by about 9 percent of the total Cache Creek inflow. Based on these results, a significant reduction in floodflows in Lower Cache Creek is not possible.

The Wilson Valley site is on Cache Creek about 5 miles downstream from the confluence with the North Fork of Cache Creek. In the early 1970's, the State Department of Water Resources conducted a foundation analysis of the onstream site as part of the Eel River project. The analysis indicated that weak foundation conditions limited the storage capacity of the Wilson Valley site to 37,000 acre-feet, and this volume would be filled with sediment in 80 to 90 years. The Corp's reconnaissance hydrologic analyses indicate that the peak discharge for the 1 in 100 chance flow at the town of Yolo would be decreased by 25 percent using a maximum storage volume of 37,000 acre-feet in the storage basin. The reduced peak discharge for the 1 in 50 chance flow event with the 37,000 acre-foot basin was found to be well above the estimated nondamaging channel capacity of lower Cache Creek. As a result, significant reductions in flood damages would not be achieved with the storage available at the Wilson Valley site.

The Capay site is downstream from Capay Dam on Cache Creek. The project would involve constructing offstream detention ponds adjacent to Cache Creek. The reconnaissance hydrologic analysis indicated that 75,000 acre-feet of detention capacity is required to decrease the peak discharge of the 1 in 100 chance flow event at the town of Yolo to the nondamaging capacity. Assuming a storage depth of 20 feet, the required detention area is estimated to be 5.9 square miles. Due to this large land requirement, as well as construction and operational difficulties, the Capay site was not considered further.

In summary, flood storage on Cache Creek was not considered further as a flood damage reduction measure. This was due largely to the relatively high costs, environmental effects, and the lack of local interest associated with storage measures.

Channel Improvements

Channel improvements could range from clearing to enlarging the existing channel. Clearing would increase conveyance capacity by reducing the amount of vegetation in the channel. Enlarging the channel would increase conveyance by increasing the flow area of the channel. Channel improvements could include enlarging existing bridges and would likely require slope protection due to increased channel velocities.

Levee Modification

Levee modifications and/or constructing new levees would protect areas on the landside of the levees from flood inundation and provide for conveyance of floodwater through the project area. Levees could be constructed along the streambank to minimize effects on adjacent lands or set back from the banks to reduce the required levee height and effects to riparian vegetation and wildlife. Slope protection would be required where scour velocities are erosive to levee embankment.

Setback Levees

A setback levee approach would involve constructing a new levee some distance from the streambank or existing levee and removing the existing levee or breaching it at various locations. This approach could be used to increase conveyance capacity while minimizing the associated increases in water-surface elevations and flow velocities. Doing so could reduce the need for improving the levee on both sides of the channel, the need for slope protection, and the environmental effects to the channel.

Backup Levees

A backup levee is a levee that is set back some distance from an existing levee system to provide a lower chance of flooding on its landside than the existing levee system provides. Unlike setback levees, the existing levees would be retained and would allow flooding of areas behind existing levees for flood events exceeding the design capacity of the existing levees. The area between the existing levees and the proposed backup levee would have the same percent chance of flooding in any given year as it would without the backup levee. The existing levee system would continue to be maintained and operated in the same manner as they are maintained. This type of system could be used to give a higher level of protection to a densely populated area such as a city while still maintaining the same level of protection to a sparsely populated area such as an agricultural production area.

FINDINGS

Structural and nonstructural measures were combined to provide flood damage reduction plans for the city of Woodland. Table 4-1 identifies those measures that were retained after the screening process.

The nonstructural measures involving raising/flood proofing structures, relocating structures, and implementing flood warning and evacuation systems were found to warrant further consideration for combining with the other measures.

In terms of structural measures, storage measures were dropped from further consideration due to high costs, environmental effects, and lack of local support. However, channel improvements, levee modifications, and construction of new levees were found to warrant further consideration.

PRELIMINARY PLANS CONSIDERED

Based on the results of the initial screening of measures and on public comments, five preliminary flood damage reduction plans were developed to represent the overall range of practical flood damage reduction opportunities available for the lower Cache Creek. In addition to the no-action plan, they include:

- Channel Clearing
- Raising Existing Levees and Constructing New Levees
- Channelization and Constructing New Levees
- Constructing Setback Levees and Raising Existing Levees
- Constructing a Flood Barrier Levee (Backup Levee)

CHANNEL CLEARING

This plan would include clearing the existing channel and would improve conveyance of floodwater within the channel area by removing riparian vegetation, sediment deposits, and other obstructions. The cleared area would be reseeded with grass, and slope protection would be placed where required. This plan was formulated largely in response to the interest expressed by some of the landowners adjacent to the creek (Figure 4-1).

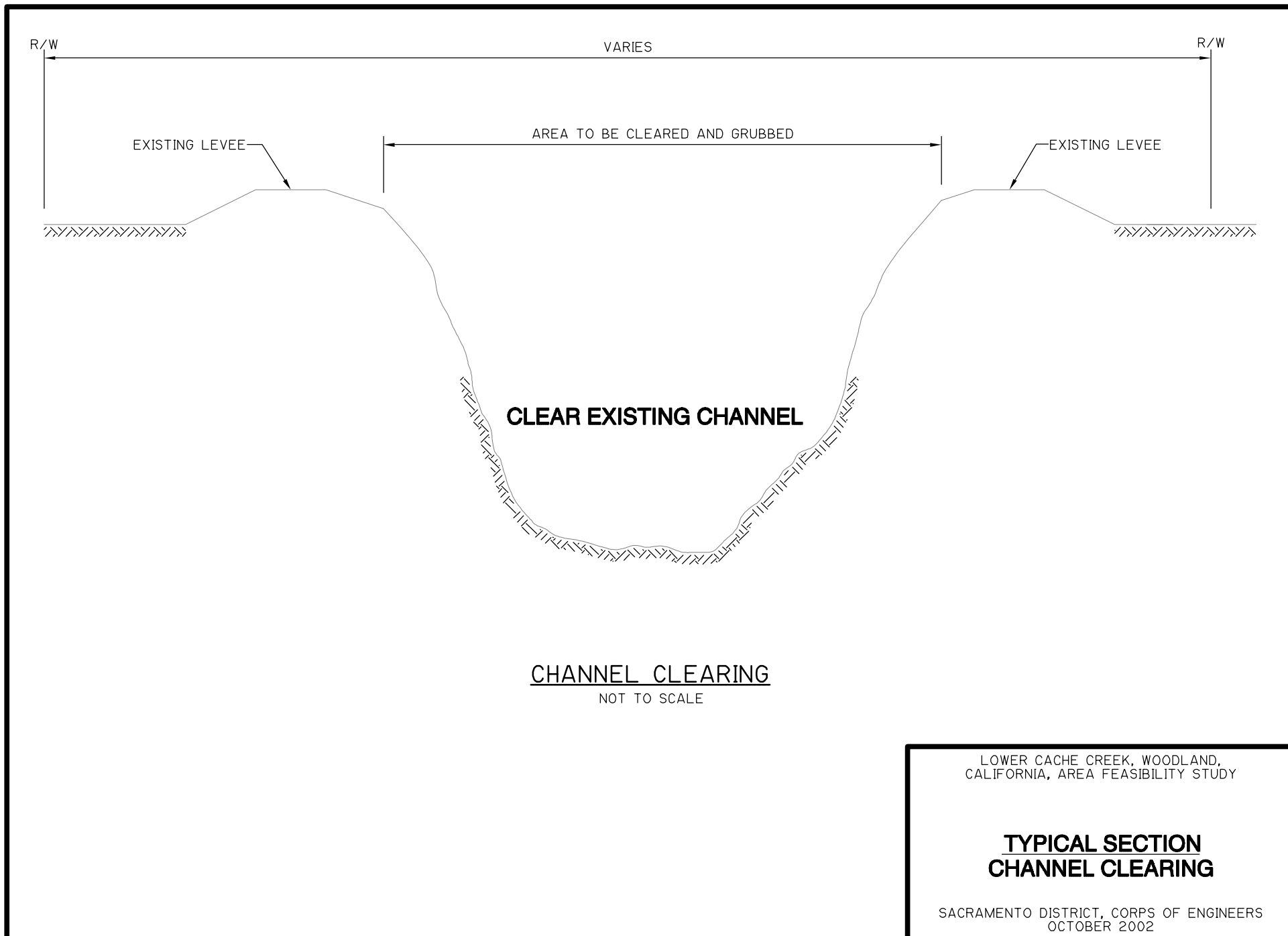


FIGURE 4-1

RAISING EXISTING LEVEES AND CONSTRUCTING NEW LEVEES

With this plan the levees would be raised on both sides along approximately 8 miles of Cache Creek from CR 97A to the Cache Creek Settling Basin. New levees would be constructed on the south bank of the creek from CR 97A upstream 2 miles. On the north bank of the levee upstream from CR 97A, 1 mile of existing project levee would be raised, and approximately 1 mile of new levee would be constructed. This plan would involve bridge replacement and slope protection where required (Figure 4-2).

CHANNELIZATION AND CONSTRUCTING NEW LEVEE

This plan combines two measures evaluated during the screening process: (1) excavating a bench along the channel and (2) constructing a new levee adjacent to the bench. These features would be constructed along a 9.3-mile reach of Cache Creek from about 1 mile west of CR 97A to the Cache Creek Settling Basin. The channel bench would be constructed at approximately the water-surface elevation associated with the 1 in 2 chance flood event and would be wide enough to maintain the design water-surface elevation at or below the PNP of the remaining existing levee. Where required, the existing levee affected by the bench would be removed and reconstructed adjacent to the bench. Bridge replacements and slope protection would be constructed as required (Figure 4-3).

CONSTRUCTING SETBACK LEVEES AND RAISING EXISTING LEVEES

Approximately 6.5 miles of setback levees would be constructed on either one or the other side of Cache Creek and existing levees on the opposite side would be raised, as required. In addition, adjacent to the 6.5-mile reach, this plan would include approximately 3 miles of newly constructed levee on both sides of the channel banks downstream from CR 96. Bridge replacements and slope protection would be constructed as required (Figures 4-4 and 4-5).

CONSTRUCTING A FLOOD BARRIER LEVEE

This plan would consist of constructing approximately 6.7 miles of new levee from CR 96 to the west levee of the Cache Creek Settling Basin (Figures 4-5 and 4-6). Approximately a 4,000-foot section of the west levee of the Cache Creek Settling Basin levee would be removed. Overflows from Cache Creek would generally flow from west to east over lands currently subject to flooding and discharge by gravity into the settling basin.

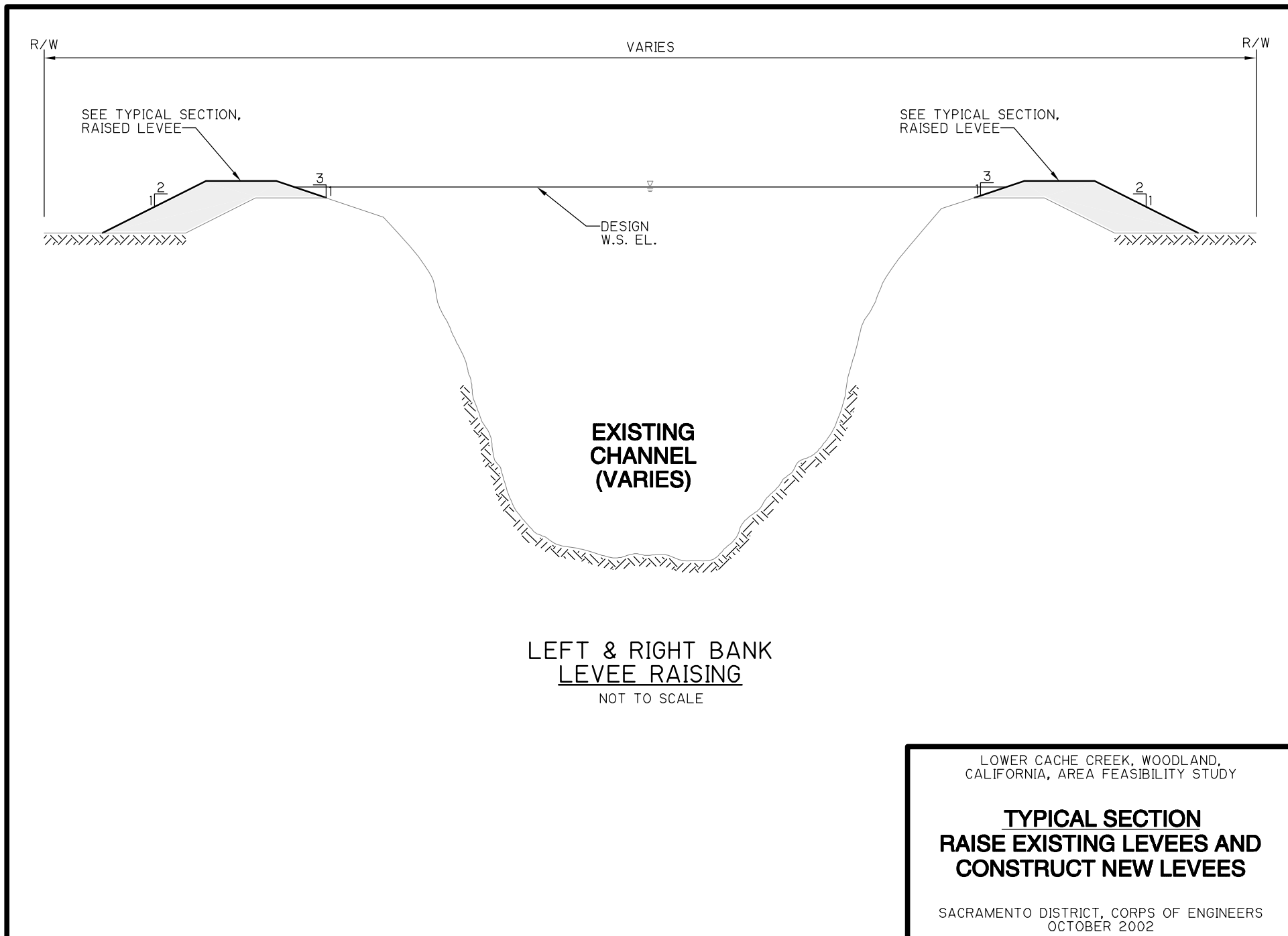
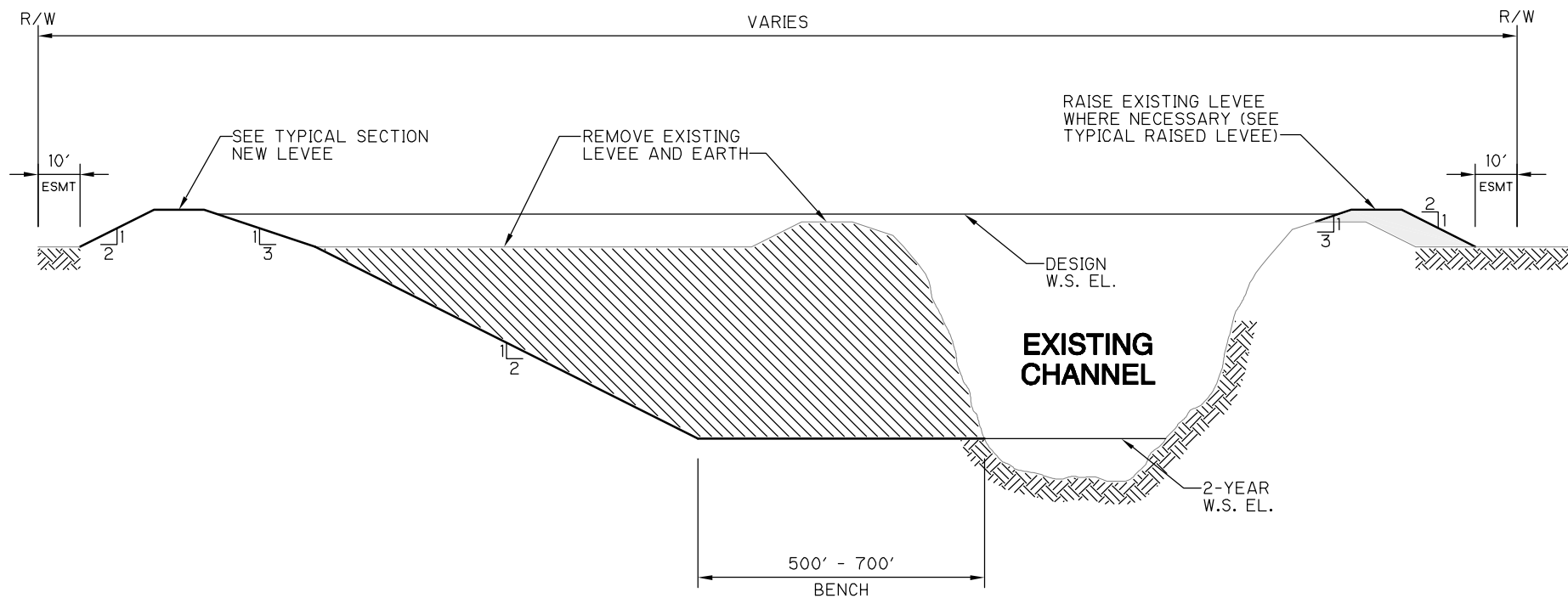


FIGURE 4-2



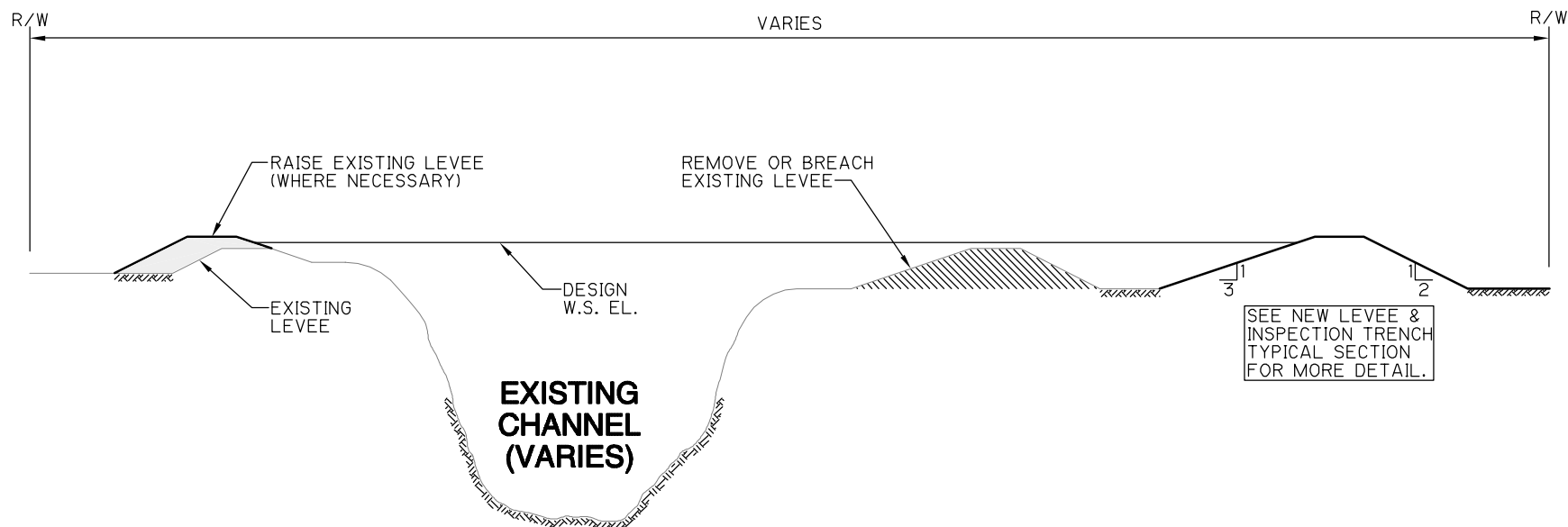
CHANNELIZATION AND CONSTRUCTING NEW LEVEES

NOT TO SCALE

LOWER CACHE CREEK, WOODLAND,
CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION CHANNELIZATION AND CONSTRUCTING NEW LEVEES

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002



SETBACK LEVEES
NOT TO SCALE

NOTE

SLOPE PROTECTION IS REQUIRED ALONG REACHES WITH VELOCITIES GREATER THAN EXISTING-CONDITIONS VELOCITIES FOR TOP-OF-LEVEE FLOWS.

LOWER CACHE CREEK, WOODLAND,
CALIFORNIA, AREA FEASIBILITY STUDY

TYPICAL SECTION
CONSTRUCTING SETBACK LEVEES
AND RAISING EXISTING LEVEES

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

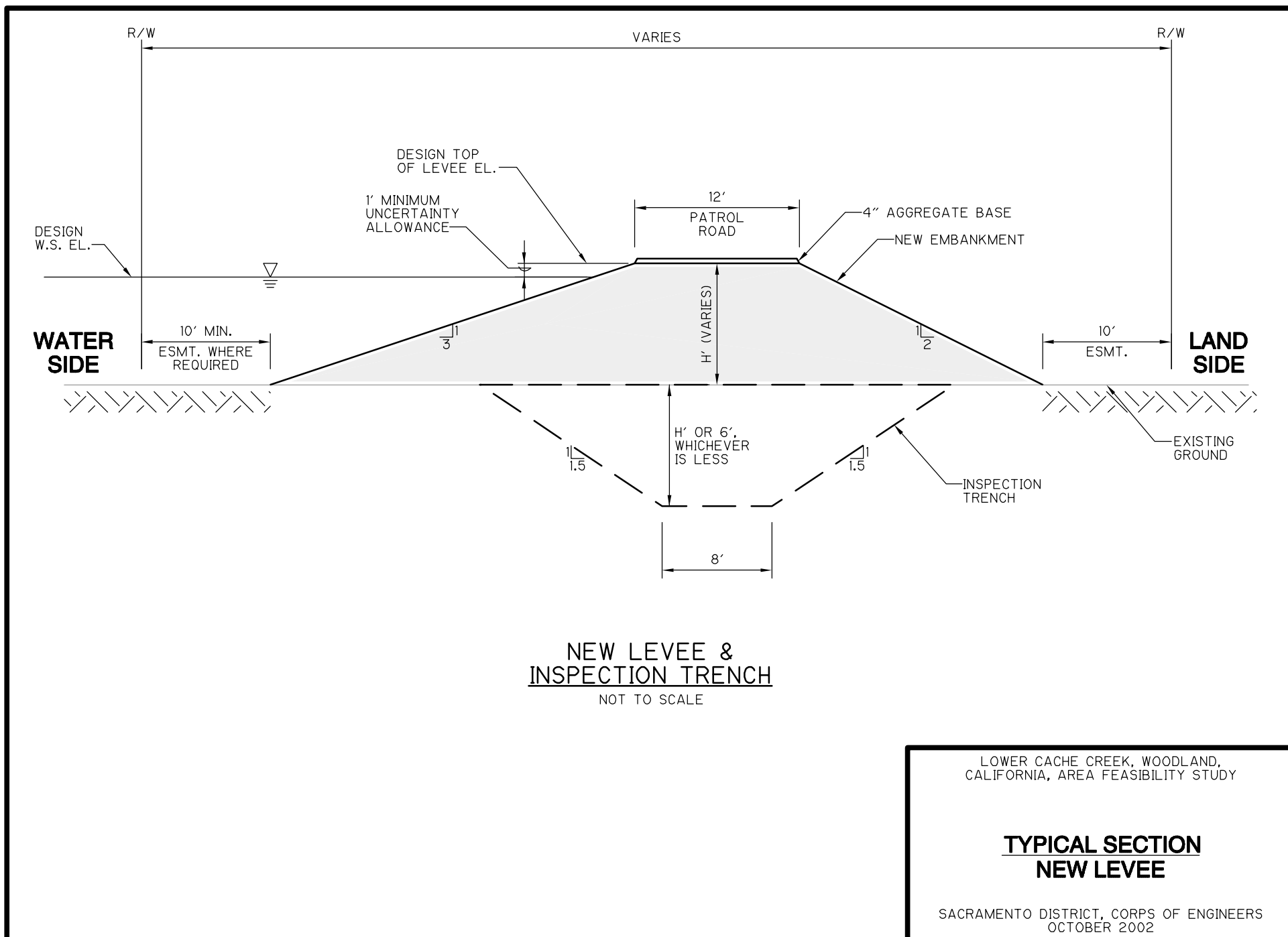
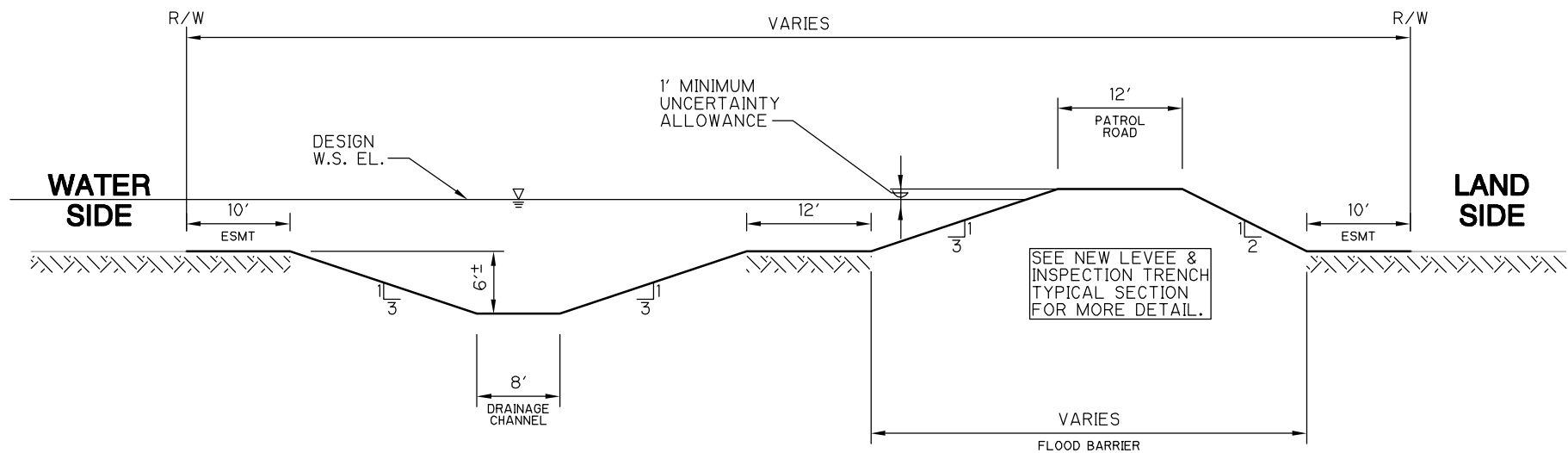


FIGURE 4-5



**LOWER CACHE CREEK
FLOOD BARRIER**
NOT TO SCALE

LOWER CACHE CREEK, WOODLAND,
CALIFORNIA, AREA FEASIBILITY STUDY

**TYPICAL SECTION
CONSTRUCTING A
FLOOD BARRIER LEVEE**

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
OCTOBER 2002

A ditch would be constructed adjacent to the levee to generate borrow material and to convey local runoff. Culverts would be placed at road and railroad crossings. Closure structures would be constructed as required at all crossings. Provisions would be made to protect some homes and structures within the associated flood plain.

A flood warning system would be implemented as well. This would allow time for evacuation of the flood plain and installation of the necessary closures.